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Improvement on Small Scale Fish Farm for Optimum Production Using Sprinkler Aerator Device

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ABSTRACT

This research is on the application of a sprinkler aerator for the aeration of fish ponds to maintain or increase dissolved oxygen level of fish pond with oxygen deficiency. The improved fish pond was achieved by maintaining the dissolving Oxygen level in fish pond using Sprinkler aerator device. The aerator device was developed for suitability to the present day fish farming methods where earthen, concrete or plastic tanks are used as pond. Aeration experiment was conducted in two surface concrete fish tanks in different days, time and different weather conditions such as sunny day, cloudy day and after midnight. Two sets of dissolved oxygen data were recorded, one from tank without aerator and another with aerator. The result shows that the device was able to increase the oxygen concentration of the aerated water tank from 3.89mg/L to 7.18mg/L which is 45.82%. There were about 503 fingerlings of catfish in the pond at the initial stage of the experiment and at the end, 485 pieces of catfish survived as against the usual of 475 pieces due to dissolved oxygen level maintained by the aerator device. This method presents solution of reducing fish mortalities in the pond and help in increasing the survival rate of the fishes. The reduction in mortality rate has significantly increased the profit from the fish farm.

Keywords: Dissolved Oxygen level without aerator, dissolved oxygen level with aerator, effect of dissolved oxygen deficiency on fishes, performance of fishes in water with reasonable dissolved oxygen content and fish mortality rate.

1. INTRODUCTION

The process of raising or maintaining the oxygen saturation of water in both natural and artificial settings is known as water aeration. The quantity of DO (Dissolved Oxygen) in the water maintains the aeration. The amount of oxygen molecules dissolved in water per volume of water is known as dissolved oxygen (DO). One of the most important markers of water quality is the quantity of DO in it (Boyd, 1990). Aquatic lives, much like humans, need a sufficient quantity of oxygen dissolved in water to live. Water contains just a

fraction of a percentage of DO, compared to air, which is usually around 21% oxygen. It's measured in milligrams per litter (mg/L), parts per million (ppm), or percentage of saturation in water. In recent years, the demand for fish is on the increase and many entrepreneurs are springing up on fish farming business. The most commonly used method of rearing fish is through artificial concrete ponds. One of the main challenges in fish farming is the fish mortality rate as a result of dissolved oxygen (DO) deficiency. The minimum safe level of dissolved oxygen for fish is 3mg/l to 4mg/l. It is well understood that supplementing dissolved oxygen in ponds with low DO may further increase the productivity of fish.

Main sources of oxygen to water body are through photosynthesis and diffusion. Any activity that affects these sources will greatly reduce oxygen levels in the pond which can lead to fish mortality. Overcast skies can cause oxygen production to diminish. The dissolved oxygen level of the fishpond fluctuates with cloudy sky or overcast sky. If such weather condition persists for more than a few hours each day, oxygen production through sunlight (photosynthesis) may be greatly affected. Death of algae in the fishpond can cause oxygen depletion. During summer, algae and other aquatic plants release oxygen to the fish in the process of producing their own food through photosynthesis. The death of these plants affects oxygen saturation in the pond. Fish stocking and feeding rate pose problem of oxygen deficiency. As farmers continue to increase production by stocking fish at greater densities and increase the feeding rate, episode of critically low dissolved oxygen concentration became more frequent. Quite often, fishes struggled to obtain oxygen at pond surface. However, frequent sorting of fish can avert mortality resulting from over stocking.

The dissolved oxygen content of the fishpond needs to be maintained above minimum safe level of 3mg/l – 4mg/l for good health condition of fish. Deficiency in dissolved oxygen content of a fishpond can have devastating effects as the fish may die almost at the same time, large fishes may feel the effects more than smaller ones. Furthermore, an electrically driven sprinkler aerator device was employed in this project to maintain the dissolved oxygen level in the fishpond hence improving the fish farm's production. In the course of literature research for this work, several areas were considered which included fish farming and production, aerator structure and its applications and several other fish farm production improving techniques being practiced.

Ebukiba and Anthony (2019) conducted study in the Karu local government area of Nasarawa State, Nigeria, on assessing the economic analysis of catfish production. The authors utilized descriptive statistics to characterise and classify the respondents' socioeconomic characteristics, and a budgeting method to assess the profitability of fish farming in the research region. The findings revealed that 35% of the tested fish farmers are between the ages of 21 and 30, and 31 and 40, respectively, and that the average age of the studied farmers is 41 years, with an average farming experience of 8 years. In addition, 55% of respondents rely on boreholes for water, whereas 5% rely on a stream or river as their primary source of water. Research by Adewuyi *et al.* (2010), it was concluded that fish production in the study area is economically rewarding and profitable. It is capable of creating employment, augmenting income and improving the standard of living of the people. In view of the findings, it was recommended that the government participates in fish farming to improve on the quantity of fish available for consumers. A research by Zhen *et al.* (2019) highlighted that production of aquaculture is of a great potential and high demand in the Asian countries. It was asserted that the production of aquaculture is increased with a good water quality in the fish pond.

Brown *et al.* (2017) did a survey in the southern part of Nigeria and recommended amongst others that Stake holders should provide enabling environment for experts to package sustainable approaches into training programs for farmers through agricultural workshops and seminars.

2. MATERIALS AND METHODS

Understanding the practice of small scale fish farming, fish ponds are made of earthen, concrete and plastic tanks of varying sizes. Concrete fish pond was used for this work due to the easy way of regulating the water source and drainage system in the pond unlike in earthen ponds.

2.1. Materials Used:

The materials used for this study were a 0.5hp motor, ½'' plastic pipe, 1'' plastic pipe, 1'' elbow, electric cable, nuts and bolts, plastic board, life buoy and oxygen meter. The materials were fabricated and assembled in the Mechanical workshop, RSU and tested in a concrete fishpond (Figure 1).

Figure 1. Testing the sprinkler aerator

2.2. Experimental Method

The experiment was conducted in two concrete tanks containing tap water. The aerator was placed at the center of one and connected to a single-phase electric power source. Thereafter, the device was operated and allowed to run for 5 hours and measurements were taken at hourly interval. Dissolved oxygen was measured by oxygen meter, water pH by pH meter, water temperature by thermometer and wind speed by anemometer. The experiments were conducted in various weather conditions such as; Sunny day without and with aerator, after midnight without and with aerator, Cloudy day without and with aerator. During the daytime, the experiment was started at 11H00 and after midnight at 00H05am. At zero hour (0 hour), the first reading was taken for each experiment and these steps were repeated for a period of 36 days. 18 sets of data were recorded taking distance from the center of the aerator towards the edge of the pond

2.3. Analytical Model

In determining the oxygen requirements in a fishpond, the equilibrium concentration of oxygen in water was determined according to Henry's law. The equilibrium concentration is the maximum concentration of oxygen which can be dissolved in water relative to the concentration of oxygen in the gas under prevailing conditions of temperature and pressure. In fishponds, gas is referred as atmospheric air, although pure oxygen also gets into the fishpond water by the oxygen production of some water plants.

The equilibrium concentration in gas-liquid systems is expressed by Henry's law (Equation 1).

$$P_{O2} = X_{O_2}.\mathrm{H} \qquad (1)$$

where

P_{O_2}= The partial pressure of oxygen in the gas phase above the liquid case of equilibrium (P_a)

X_{O_2}= Mole fraction of the oxygen (liter)

H = Henry's constant (P_a)

The partial pressure of one component of a gas mixture is proportional to the volume fraction of that component (Equation 2).

$$P_{O_2} = \Phi_{O_2}.\mathrm{P} \qquad (2)$$

where

P = Pressure of gas mixture (P_a)

Φ_{O_2} = Volume fraction. 21 % of atmospheric air is oxygen thus, the volume fraction is: Φ_{O_2} = 0.21 (0.2099)

The oxygen concentration expressed in mole fraction (X_{O_2}) can be converted into weight fraction W_{O_2} (Equation 3).

$$W_{O_2} = \frac{X_{O_2}}{1-X_{O_2}} \cdot \frac{M_{O_2}}{M_{H_2O}} (kg.kg^{-1}) \qquad (3)$$

where

M_{H_2O} = 18.01 molecular weight of water

M_{O_2} = 31.9981 molecular weight of oxygen

Because of the small value of X_{O_2} thus:

$$\frac{X_{O_2}}{1-X_{O_2}} = X_{O_2} \qquad (4)$$

Hence,

$$W_{O_2} = X_{O_2} \cdot \frac{M_{O_2}}{M_{H_2O}} \qquad (5)$$

The weight fraction (W_{O_2}) can be converted into weight concentration (C_s) (Equation 6)

$$C_s = \frac{W_{O_2}}{S_{H_2O}} (kg.m^{-3}) \qquad (6)$$

where

C_s = Weight concentration of oxygen at saturation (kg m^{-3})

S_{H_2O} = Density of solution H_2O.

Based on the equations given, the weight concentration of oxygen at saturation (C_s) can be

$$C_s = \frac{\Phi_{O_2}.P.S_{H_2O}}{H} \cdot \frac{M_{O_2}}{M_{H_2O}} (kg.m^{-3})$$

$$C_s = \frac{1000.\Phi_{O_2}.P.S_{H_2O}}{H} \cdot \frac{M_{O_2}}{M_{H_2O}} (g.m^{-3})$$

Since we know that 1mm H_2O = 9.80665 Pa

Therefore,

$$P_s = P_o.e^{(-\frac{S_0 - g}{P_0}.z)} \quad (7)$$

From the gas law

$$\frac{P_0}{S_0} = R\theta \quad (8)$$

Where

P0 = Atmospheric pressure at sea level (pressure

at 45° North at sea level = 101325 Pa)

S0 = Density of air at sea level = 1.2928 kg $^{-3}$

R = Gas constant (for air, R = 287. 041s.kg^{-1}K^{1})

θ = Temperature

$$P_z = P_x.e^{(-\frac{g}{R\theta}.z)} \quad (9)$$

where

z = Elevation above sea level (m)

P_z = Atmospheric pressure at elevation z (m)

g = Acceleration due to gravity (9.81 ims^{-2})

R = Gas constant (for air, R = 287.041s.kg^{-1}.K^{1}) θ = Temperature

The oxygen capacity of the aerator is the amount in grams of oxygen that can be dissolved in 1m^3 of water in 1 hour. Since at normal atmospheric pressure, water temperature is 10°C and its initial dissolved oxygen will be zero (0 mg/L).
The relationship between the oxygenation capacity (OC) and mass transfer is given in equation 10.

$$OC = K_La\,(10^oC).\ C_s\,(10^oC) \quad (10)$$

However, the value of the oxygen capacity at different temperature and atmospheric pressure can be modeled using equation 11.

$$OC(\theta; P) = OC\frac{C_{s\theta}}{C_{s10^oC}}\sqrt{\frac{K_{L\theta}}{K_{L10^oC}}}\ .-\ \frac{P}{P_0} \quad (11)$$

where

$\sqrt{\frac{K_{L\theta}}{K_{L10^oC}}}$ = Ratio between the temperature at θ to atmospheric temperature at 10°C

$C_{s\theta}$ = Weight concentration of O_2 saturation with temperature = θ (kg m^{-3})

C_{s10^oC} = Weight concentration of O_2 saturation with temperature =10°C (kgm^{-3})

P_0 = Atmospheric pressure at sea level

P = Pressure of aerator

To calculate the oxygen intake (O_t) when the same aerator is used for oxygenation of a larger water volume than 1 m^3 is given in equation 12 below.

$$O_t = V.OC\ (gh^{-1}) \quad (12)$$

where

V = Volume of water in the pond

O_t = Temperature at i20°C under normal atmospheric pressure.

OC = Initial dissolved oxygen concentration.

$$iO_{ts} = \frac{OC.V}{P} \text{ (g ih}^{-1}\text{ ikW}^{-1}) \qquad (13)$$

where

P = Power input of the aerator (kW).

O_{ts} = Specific total oxygen intake (shows the efficiency of the oxygenation related to the power input).

The standard oxygen transfer rate of an aerator is the quantity of oxygen being transferred to a water body in unit time under standard conditions (water temp = 20°C at DO concentration of 0 mg/L and 1 atmospheric pressure)

$$SOTRi= iK_{La20} \text{ ix i}(C^*- iC_o) \text{ ix iV} \qquad (14)$$

$$i= iK_{La20} \text{ ix i9.07 ix iV i}10^{-3}$$

where

iSOTR i= iStandard iOxygen iTransfer iRate (kgO₂/h)

$$\text{But } K_{La20} = \frac{K_{LaT}}{\theta^{T-20}} \qquad (15)$$

where

K_{LaT} = Overall oxygen transfer coefficient at T°C (h^{-1})

θ = Temperature correction factor (1.024) for clean water)

C^* = Saturation value of DO at test condition (mg/L)

C_o = Initial DO concentration (mg/L)

9.07 = Saturated DO concentration of clean water at 20°C and standard atm pressure

V = Volume of water (m^3)

10^{-3} = Factor for converting g to kg.

Theoretically, it was observed that aerators with larger capacities transferred more oxygen than lesser sizes of aerators. This led to the model of a Standard I Aeration Efficiency (SAE) to be used in computing the amount of oxygen transferred per unit energy input (Boyd, i1998) is expressed in equation 20. I

Mathematically,

$$SAE == \frac{SOTR}{P} \text{ (kgO}_2\text{/kWh)} \qquad (16)$$

where

P = Power applied to aerator (kW)

From Boyd (1998), the actual Oxygen Transfer Rate (OTR) of an aerator in a fishpond is expressed in equation 21.

$$iOTR = \frac{SOTR(\alpha(1.024)T-20(\beta C_S - C_P))}{9.07} \quad (17)$$

where

C_S = Saturation concentration of pond water (mg/L) at T°C

C_P = Initial DO concentration of pond water (mg/L) at T°C

$$\alpha = \frac{\text{KLa20 pond water}}{\text{KLa20 tap water}} = 0.75$$

$$\beta = \frac{\text{DO saturation concentration of pond water}}{\text{DO saturation concentration of tap water}}$$

= 0.98

3. RESULTS AND DISCUSSION

For the results and discussion of this project, the data were collected at two (2) instances; firstly, without the aerator device and secondly with the aerator device to observe the effect of dissolved oxygen on the mortality rate of the fishes in the pond.

3.1. Parameters from fishpond without Aerator

The data of the dissolved oxygen (DO), water pH, water temperature and wind speed in the fishpond without aerator device were measured directly using an oxygen meter, pH scale, thermometer, and anemometer respectively for different weather conditions (Table 1 to 3).

Table 1: Sunny Day without Aerator

S/N	Time (Hrs)	Water Temp (℃)	DO (mg/l)	pH	Wind Speed (m/s)
1	0	22.3	4.12	5.2	4.2
2	1	20.1	4.50	5.1	4.2
3	2	21.5	4.95	5.3	4.0
4	3	22.2	5.20	5.2	3.9
5	4	19.0	5.70	5.3	4.4
6	5	21.0	6.10	5.4	4.2

Table 2: Cloudy Day without Aerator

S/N	Time (Hrs)	Water Temp (℃)	DO (mg/l)	pH	Wind Speed (m/s)
1	0	23.0	4.50	5.1	4.2
2	1	23.7	4.67	5.3	4.2
3	2	24.2	4.85	5.3	4.0
4	3	24.6	4.92	5.4	3.9
5	4	25.3	5.20	5.5	4.4
6	5	25.7	5.60	5.4	4.2

Table 3: After Midnight without Aerator

S/N	Time (Hrs)	Water Temp (℃)	DO (mg/l)	pH	Wind Speed (m/s)
1	0	23	5.38	5.3	3.9
2	1	24	4.93	5.2	4.1
3	2	22	4.33	5.3	4.0

4	3	25	4.10	5.4	4.1
5	4	24	5.00	5.1	4.1
6	5	23	3.89	5.3	4.2

Table 4: DO data of fishpond for different weather conditions without aerator

Weather Condition.	**Time (Hours)**				
	1hr	**2hrs**	**3hr**	**4hr**	**5hr**
Sunny Day(mg/L)	4.50	4.95	5.20	5.70	6.10
Cloudy Day(mg/L)	4.67	4.85	4.92	5.20	5.60
After Midnight (mg/L)	4.93	4.33	4.10	4.00	3.89

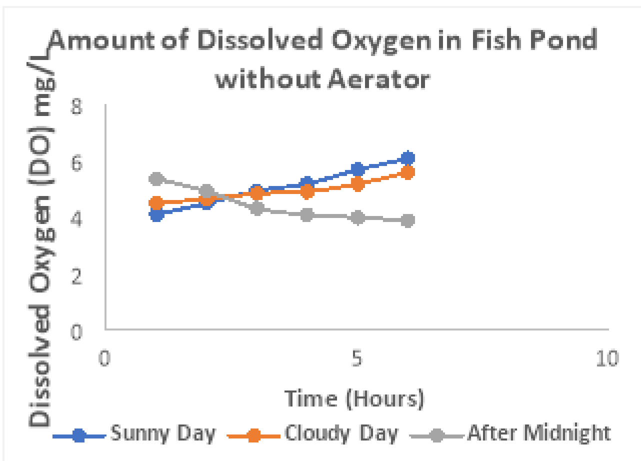

Figure 2: Dissolved Oxygen data of fishpond for different weather condition without aerator.

3.2. Parameters from fishpond with aerator device

Calculating for oxygen intake for the fishpond at different weather condition of the experiment. (Equation 13)

$$O_{ts} = \frac{V.OC}{P} \,(gh^{-1})$$

where

V = Volume of the pond = 218.7 m3

P = Power of Aerator (kW) = 0.375kW

OC_{20} = 28.23 gm3/h

V x OC = 218.7 x 28.23

= 6173.90 g/h = 6.173 kg/h

$$O_{ts} = \frac{6.173}{0.375} = 16.46 \text{kg/h/kW}$$

The valve of V, T, Cs, K_{LaT}, (at different instance) are used to calculate K_{La20}, SOTR and SAE of different weather conditions. (Equation 14 and 15)

3.2.1. Sunny Day with Aerator

SOTR = K_{La20} x (C*- C_o) x V

= K_{La20} x 9.07 x V 10^{-3}

$K_{La20} = \frac{K_{LaT}}{\theta^{T-20}}$

Combining both equations, we have:

SOTR = $\frac{K_{LaT}}{\theta^{T-20}}$ x 9.07 x V (10^{-3})

The digital oxygen meter was used to measure the temperature of the pond water.

For T = 22°C, K_{LaT} = 2.16 mg/L

SOTR = $\frac{2.16}{1.024^{22-20}}$ x 9.07 x 218.7 (10^{-3})

= 2875 g/O_2/hr = 2.88 kgO_2/h

For T = 24 °C, K_{LaT} = 1.38 mg/l

SOTR = $\frac{1.38}{1.024^{24-20}}$ x 9.07 x 218.7 (10^{-3})

= 2489g/O_2/hr = 2.49kgO_2/h

For T = 25 °C, K_{LaT} = 1.21 mg/l

SOTR = $\frac{1.21}{1.024^{25-20}}$ x 9.07 x 218.7 (10^{-3})

= 2131 = 2.13kgO_2/h

For T = 27 °C, K_{LaT} = 0.94 mg/l

SOTR = $\frac{0.94}{1.024^{27-20}}$ x 9.07 x 218.7 (10^{-3})

= 1579 = 1.58kgO_2/h

For T = 28 °C, K_{LaT} = 0.64 mg/l

SOTR = $\frac{0.64}{1.024^{28-20}}$ x 9.07 x 218.7 (10^{-3})

= 1050 = 1.05kgO_2/h

For T = 26°C, K_{LaT} = 0.14 mg/l

SOTR = $\frac{2.16}{1.024^{24-20}}$ x 9.07 x 218.7 (10^{-3})

= 240.87 = 0.24kgO_2h

Table 5: Dissolved Oxygen Measured on a Sunny Day with Aerator

Time (Hour)	DO (Cm) (mg/l)	Water Temp (℃)	Do Deficit (mg/l)	In$(C_s$-$C_m)$ (mg/l)	SOTR KgO2h^{-1}	SAE (SOTR/P) KgO2/kWh^{-}
0	4.12	22	4.56	1.52	2.88	7.68
1	4.70	24	3.98	1.38	2.49	6.64

2	5.32	25	3.36	1.21	2.13	5.68
3	6.13	27	2.55	0.94	1.58	4.21
4	6.78	28	1.90	0.64	1.05	2.80
5	7.53	26	1.15	0.14	0.24	0.64

3.2.2 Cloudy Day with Aerator

For cloudy day with aerator, the experiment was started around 12:00 am left to run for 5 hours while dissolve oxygen was measured at intervals.

For T = 23 °C, K_{LaT} = 1.38 mg/L

$$SOTR = \frac{2.16}{1.024^{23-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 2549 = 2.55 KgO_2h^{-1}

For T = 22 oC, KLaT = 1.33 mg/L

$$SOTR = \frac{1.33}{1.024^{22-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 2515 = 2.52Kg O_2h^{-1}

For T = 24 °C, K_{LaT} = 1.03 mg/L

$$SOTR = \frac{1.03}{1.024^{24-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 1858 = 1.86Kg O_2h^{-1}

For T = 24oC, KLaT = 1.03 mg/L

$$SOTR = \frac{1.03}{1.024^{24-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 1858 = 1.86 Kg O_2h^{-1}

For T = 23oC, KLaT = 0.85 mg/L

$$SOTR = \frac{0.64}{1.024^{23-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 1570 = 1.57Kg O_2h^{-1}

For T = 25oC, KLaT = 0.39 mg/L

$$SOTR = \frac{0.39}{1.024^{25-20}} \times 9.07 \times 218.7\ (10^{-3})$$

= 687.1 = 0.68 Kg O_2h^{-1}

Table 6: Dissolved Oxygen Measured on a Cloudy Day with Aerator

Time (Hour)	DO (Cm) (mg/l)	Water Temp (℃	DO Deficit (mg/l)	In(C_s-C_m) (mg/l)	SOTR KgO2h^{-1}	SAE (SOTR/P) KgO2/kWh^{-}
0	4.70	23	3.98	1.38	2.87	6.80
1	4.91	22	3.77	1.33	2.52	6.72

2	5.67	24	3.01	1.03	1.86	4.96
3	5.87	24	2.81	1.03	1.86	4.96
4	6.33	23	2.35	0.85	1.57	4.19
5	7.21	25	1.47	0.39	0.68	1.81

3.2.3. After Midnight with Aerator

For T = 20 oC, KLaT = 1.22 mg/L

SOTR = $\frac{1.22}{1.024^{20-20}}$ x 9.07 x 218.7 (10^{-3})

= 2420 = 2.42 Kg O_2h^{-1}

For T = 19 oC, KLaT = 1.11 mg/L

SOTR = $\frac{1.33}{1.024^{19-20}}$ x 9.07 x 218.7 (10^{-3})

= 2254 = 2.25 Kg O_2h^{-1}

For T = 21 oC, KLaT = 1.01 mg/L

SOTR = $\frac{1.01}{1.024^{21-20}}$ x 9.07 x 218.7 (10^{-3})

= 1956 = 1.96 KgO_2h^{-1}

For T = 20 oC, KLaT = 0.85 mg/L

SOTR = $\frac{0.85}{1.024^{20-20}}$ x 9.07 x 218.7 (10^{-3})

= 1686 = 1.69 KgO_2h^{-1}

For T = 20 oC, KLaT = 0.61 mg/L

SOTR = $\frac{0.61}{1.024^{23-20}}$x 9.07 x 218.7 ($10^{-3}$)

= 1210 = 1.21 KgO_2h^{-1}

For T = 22 oC, KLaT = 0.39 mg/L

SOTR = $\frac{0.46}{1.024^{22-20}}$ x 9.07 x 218.7 (10^{-3})

= 737.77 = 0.74 KgO_2h^{-1}

Table 7: Dissolved Oxygen Measured After Midnight (12:00 am) with Aerator

Time (Hour)	DO (Cm) (mg/l)	Water Temp (℃	DO Deficit (mg/l)	In(C_s-C_m) (mg/l)	SOTR KgO2h^{-1}	SAE (SOTR/P) KgO2/kWh^{-}
0	5.30	20	3.38	1.22	2.42	6.45
1	5.65	19	3.03	1.11	2.25	6.00
2	5.93	21	2.75	1.01	1.96	5.23
3	6.34	20	2.34	0.85	1.69	4.51
4	6.84	20	1.84	0.61	1.21	3.23
5	7.12	22	1.58	0.46	0.74	1.97

Table 8: DO data of fishpond for different weather conditions with aerator

Weather Condition.	Time (Hours)				
	1hr	**2hrs**	**3hr**	**4hr**	**5hr**
Sunny Day(mg/L)	4.70	5.32	6.13	6.78	7.52
Cloudy Day(mg/L)	4.91	5.67	5.87	6.33	7.21
After Midnight (mg/L)	5 .65	5.93	6.34	6.84	7.12

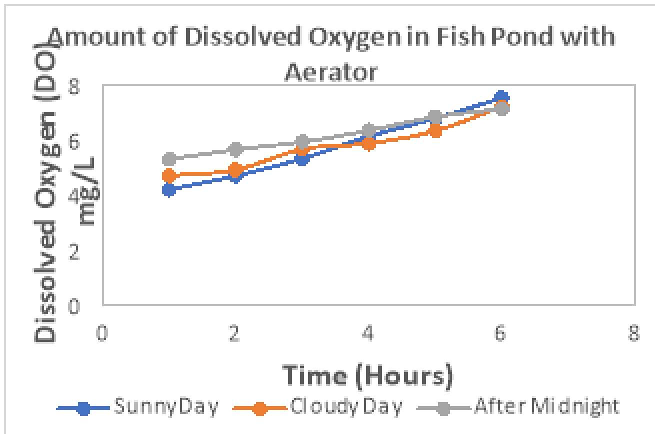

Figure 3: Dissolved Oxygen data of fishpond for different weather condition with aerator

The parameters of the fishpond without the aerator device for the three weather conditions were measured directly using digital oxygen meter for dissolved oxygen, thermometer for water temperature, pH scale for water pH and anemometer for wind speed as shown in Table 1 to 3. For sunny days without aerator (Table 1), it was clearly seen that the dissolved oxygen level increased as the sun rises from 0 hrs to 5 hrs.

On cloudy day, it was observed that there was an increase in dissolved oxygen level from same time with sunny day (11hrs) until late in the afternoon (Table 2). However, at midnight, the amount of dissolved oxygen in the pond was seen reducing towards the dawn of the day (Table 3). The drop in oxygen level was because of lack of sunlight for photosynthesis. The dissolved oxygen readings from these three weather conditions are combined in Table 4 and represented in a graph as shown in Figure 2. However, for fishpond with aerator (Table 5 to 7), the aerator didn't make much impact on sunny day compared to the value on sunny day without aerator device. In (Table 6), the aerator was able to significantly increase the dissolved oxygen level in the pond to 7.53mg/L when the height attainable without aerator was 6.10mg/L.

The aerator really made an impact at midnight operation to boost the oxygen level from 5.65 to 7.12mg/L (Table 7). The readings from the three weather conditions with aerator were combined in Table 8 and represented in Figure 3. The Standard Oxygen Transfer Rate (SOTR) and the Standard Aerator Efficiency (SAE) were computed using the overall oxygen transfer coefficient. The values obtained were:

1. for sunny day, overall oxygen transfer coefficient was from 0.14 to 1.52, SOTR was 0.24 to 2.88 and SAE from 0.64 to 7.68 (Table 5).
2. for cloudy day, overall oxygen transfer coefficient was from 0.39 to 1.38, SOTR ranges from 0.68 to 2.87, while SAE was from 1.81 to 6.80 (Table 6)
3. When computed for midnight hours, overall oxygen transfer coefficient was from 0.46 to 1.22, SOTR was from 0.74 to 2.42 and SAE from 1.97 to 6.45 (Table 7)

4. CONCLUSION

According to the research findings, there was a significant increase in dissolved oxygen content in the fishpond. The most significant increase was observed during the midnight time since lack of microbial activities naturally reduces the level of dissolved oxygen in the pond. The aeration device was able to boost and maintain the dissolved oxygen up to 7.12m/L from a previous

3.89mg/L. This increase in overall dissolved oxygen affected the survival rate of the fishes in the fishpond. There was a significant decrease in life expectancy of the fish from an initial 85% survival rate to 95% survival rate. This reduction in mortality rate has significantly increased the profit from the fishpond farm.

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Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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